Section 1
Introduction

This document is the remedial investigation (RI) portion of an RI/feasibility study (FS) that was conducted for the Calcasieu Estuary in Calcasieu Parish, Louisiana. The Calcasieu Estuary is located in the southwestern corner of Louisiana, predominately in Township 10 South, Range 9 West (Figure 1-1). The study area covers approximately 50 square kilometers (km^2), extending from the saltwater barrier located north of Lake Charles to Moss Lake, and is situated north of the intersection of the Calcasieu River Ship Channel with the Intracoastal Waterway (ICW). The City of Lake Charles, Louisiana (LA) is located within the study area, as well as several other smaller neighboring cities. The estuary is created by saltwater migrating north from the Gulf of Mexico via the Calcasieu River and freshwater draining toward the Gulf from numerous inland rivers, bayous, and lakes. The estuary supports a diverse aquatic ecosystem, which is surrounded by a typical industrialized city.

The RI/FS process has been initiated for the Calcasieu Estuary by the U.S. Environmental Protection Agency (EPA) Region VI under EPA's Region VIII Response Action Contract (RAC) No. 68-W5-0022, Work Assignment No. 941-RICO-06ZZ. EPA is addressing threats to human health and the environment related to uncontrolled releases of organic and inorganic chemicals to the estuary under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, and the National Oil and Hazardous Substance Pollution Contingency Plan (NCP). It is important to note, however, that the Calcasieu Estuary is not a Superfund site by virtue of listing on the National Priorities List (NPL). Instead, CERCLA provisions allow for sites to progress through, but not beyond, the RI/FS process without a Hazard Ranking System (HRS) score. RI Phase I sampling and analysis was conducted between December 1999 and March 2000, and RI Phase II sampling and analysis, described in detail in Section 4, was conducted between November 2000 and January 2001.

Industrial development, including chemical manufacturing and distribution, and petroleum refining has been prevalent in the Lake Charles area since the early 1920s and has impacted the estuary through the release of hazardous chemicals (Curry et al. 1997). Facility discharges, urban and agricultural activities, dredging, stormwater runoff, and accidental releases have contributed to contaminated groundwater and surface water in and around the industrial areas. These same activities also have resulted in contaminated sediments within the various surface waters in the estuary. Further, fish and shellfish within the estuary have been impacted by industrial contaminants, prompting the State of Louisiana to issue health advisories for the Calcasieu Estuary (Louisiana Department of Environmental Quality [LDEQ] 1999 and Louisiana Department of Health and Hospitals [LDHH] 2000). These health advisories inform people of the activities (e.g., swimming, boating, fishing, and wading) that may be unsafe for a certain water body. The advisories also inform

people of certain types of fish or shellfish from that water body that may not be safe to eat or consume in large quantities.

1.1 Purpose of the Remedial Investigation

The purpose of the RI is to gather sufficient information to define the nature and extent of chemical contamination in sediment, surface water, and biota within the Calcasieu Estuary and to support ecological and human risk assessments. The RI was conducted in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988). Data generated in conjunction with the RI will also be used to support the FS and the design and implementation of any remedial actions within the Calcasieu Estuary. The RI was conducted in two phases of investigation. The specific objectives of Phases I and II of the RI include:

Phase I

- Use historical data to identify contaminants of potential concern (COPCs) and develop the analytical protocol to evaluate the nature and extent of contamination in the estuary
- Conduct a statistically-based sampling program for sediment and surface water across the estuary that will support RI and FS reporting and human health and ecological risk assessments
- Use Phase I data to identify specific areas of varying degrees of contamination for evaluating contaminant gradients (if present) during Phase II

Phase II

- Conduct focused sampling of sediment and surface water to minimize Phase I data deficiencies (e.g., elevated reporting limits)
- Evaluate contaminant gradients in sediment
- Collect sediment and surface water samples to characterize selected sources of organic and inorganic COPCs to the estuary
- Collect biota samples to characterize potential impacts to selected groups of fauna within the estuary
- Collect sediment, surface water, and biota samples to characterize localized reference areas that are outside the industrial impacts of the study area
- Assess risk to human health using reasonable maximum exposure and central tendency exposure calculations for residential, commercial/industrial worker, and recreational user populations

- Assess risk to ecological receptors using hazard quotients, sediment quality triad data, and food chain modeling

1.2 Regulatory Framework

On November 7, 1997, EPA, LDEQ, National Oceanic and Atmospheric Administration (NOAA), and the Department of the Interior (DOI) met with nine industries, later to be known as the Calcasieu Estuary Environmental Action Group (CEEAG), to discuss a potential cooperative agreement where industry would commit to performing an RI/FS for the estuary and funding EPA and LDEQ RI/FS oversight costs and community involvement activities. The CEEAG agreed and documented their commitment in a November 14, 1997 letter to EPA. The commitments by industry included: (1) providing oversight costs to EPA, LDEQ, and all natural resource trustees; (2) providing costs for community outreach; (3) signing a tolling/standstill agreement with NOAA and DOI; and (4) entering into a cooperative investigation/remedial process using an EPA enforceable agreement (consent decree or administrative order of consent). The CEEAG asked that a detailed, negotiated statement of work (SOW) be attached to this enforceable agreement. They further requested that all natural resource damage assessment (NRDA) claims and NPL scoring/listing of the Calcasieu Estuary be halted during this period of negotiations.

By January 1999, the CEEAG membership that began with nine industries had been reduced to three and no agreement between EPA and industry potentially responsible parties (PRPs) was in place. Therefore, EPA decided, in the interest of the public health, welfare, and the environment, to implement a government-lead RI/FS under CERCLA.

CERCLA provides the federal government with authority to develop long-term solutions for those sites that pose unacceptable levels of risk to human and ecological receptors and to arrange for the restoration of damaged natural resources then determine who is liable for the cost of the actions through cost recovery. The RI/FS process under CERCLA for the Calcasieu Estuary includes:

- **RI**: The RI serves as the mechanism for collecting data to characterize site conditions, determine the nature and extent of environmental impacts, and assess associated risk to human health and the environment.

- **FS:** The FS is the mechanism for the development, screening, and detailed analysis of remedial alternatives.

In addition to EPA's use of the data to promote cleanup, NOAA trustees will use the RI data to conduct an NRDA. The NRDA enables natural resource trustees to focus on significant environmental injuries, plan and implement efficient and effective restoration of the injured natural resources, and encourage public and responsible party involvement in the restoration process.

The NRDA process is divided into three phases:

- **Preassessment:** The trustees evaluate injury and determine whether they have the authority to pursue restoration and if it is appropriate to do so.
- **Restoration Planning**: The trustees evaluate and quantify potential injuries and use that information to determine the appropriate type and scale of restoration actions.
- **Restoration Implementation**: The trustees and/or responsible parties implement restoration, including monitoring and corrective actions.

1.3 Site History

Industrial development dominates much land within and around the Calcasieu Estuary. This development dates back to the late 1800s and is directly related to improvements of the Calcasieu River and the Calcasieu River Ship Channel. Initially, Calcasieu Lake had a single major freshwater inflow at the north and a single outflow to the Gulf of Mexico at the Calcasieu Pass. The Calcasieu River had a natural channel that meandered through Calcasieu Lake with a maximum depth of 4 meters (DeRouen and Stevenson 1987). A shallow bar, about 1 meter below the water surface at Calcasieu Pass, effectively prevented saltwater intrusion into the Calcasieu River/Lake Complex (DeRouen and Stevenson 1987). This barrier was removed in 1871 to allow ship traffic to Lake Charles. The first record of commercial navigation on the river of any consequence is for the period following the Civil War (Shutts 1946). The early inhabitants of Lake Charles used schooners and other vessels to navigate the Calcasieu River as a path of commerce to obtain merchandise, deliver lumber, and float timber (Kaufman 1948). Soon after the Civil War, Lake Charles officially became a port when the Calcasieu pass was made a port of entry by an act of Congress, and a customs office was established at Cameron (Shutts 1958) (Figure 1-1). Just before 1900, the Calcasieu Pass was improved and jetties were constructed, thus, opening the river to larger schooner traffic carrying lumber from numerous sawmills in this area to Mexico, the east coast of the United States, and continental Europe (Shutts 1946).

Chemical manufacturing and petroleum refining companies first appeared in the Calcasieu Parish vicinity during the early 1920s, with the discovery of nearby petroleum and natural gas reserves. Access to water transportation provided further incentive for industrial development. To retain industrial strength, the people of Lake Charles wanted a seaport. In 1921, after being denied federal funding, the people of Lake Charles decided to build a ship channel and port facilities with their own money (Shutts 1946). By 1926, Calcasieu Parish was served by the Port of Lake Charles with two outlets to the Gulf: (1) the Calcasieu River Ship Channel to the intersection with Intracoastal Canal to the Sabine River and thence to sea through Port Arthur, Texas and (2) the new Calcasieu Channel crossing Calcasieu Lake. As the business of the Port doubled, the War Department officially took over maintenance of the ship channel in 1928.

In 1934, a formal request was made to Congress to construct (i.e., improve) a direct channel approximately 56 km south from Lake Charles to Calcasieu Pass. In 1937, the approval of the engineer board of the Chief of Engineers and the River and Harbors Committees of Congress was secured. Work was started in 1938. The ship channel from Lake Charles to the Gulf of Mexico was to have a depth of 10 meters (m), a width of 75 m, and a turning basin 150 m wide and 605 m long at Lake Charles. The estimated cost of ship channel construction was $96,600,000 (Manufacturers' Record 1940).

In addition, the onset of World War II was a catalyst for further industrial development in the Calcasieu Estuary. Abundant raw materials, like crude oil and natural gas, coupled with acreage, water resources for manufacturing, and a commercially navigable access artery for ships and barges led to rapid industrial development. Among the facilities whose growth was driven largely by wartime demand are the Conoco refinery, completed in 1941, the Firestone synthetic rubber plant, which began production in 1943, and the Cities Service refinery (now Citgo), brought on line in 1944.

Economic prosperity in the postwar years continued to spur growth in manufacturing, leading several to choose the Lake Charles industrial corridor for their facilities. Among those was the caustic soda and chlorine plant opened in 1947 by the Columbia-Southern Company, a subsidiary of Pittsburgh Plate Glass Company (now PPG Industries [PPG]). PPG still owns and operates the much-expanded plant. Another example of the area's immediate postwar industrial development was Cit-Con Oil Company (1949), a lubricants and wax plant built and operated jointly by Cities Service Company and Conoco.

Industrial development in the area has been steady since those postwar years. The Davison Chemical Company catalyst plant (now Grace Davison) opened in 1953, as well as the 1959 completion of the Gulf States Utilities Nelson Power Station (now owned and operated by Entergy, Inc.).

In 1961, the Hercules polyolefins plant (now Montell, Inc.) began operation, followed also in 1961 by the formation of Conoco Chemicals (changed to Vista in 1984, now known as Sasol North American Inc. (Sasol), which took over in 1984 as owner and operator of the Conoco complex chemical manufacturing facility. Air Liquide began operations on the estuary in 1963 as Lincoln Big Three. Reynolds Metals opened their local facility in 1969.

In the mid-1970s, several companies started up operations in Lake Charles. Jupiter Chemicals opened its doors in 1975, followed closely that same year by Tetra, Certain-Teed, and SRI (now Chemical Waste Management). The Gulf Oil Company calcined coke plant, now Venco, opened in 1978.

Recent years brought additional changes to the Lake Charles industrial landscape. Trunkline LNG opened its facility in 1981. In 1984, the Cities Service Company was

bought out by Occidental Petroleum. This venture ultimately resulted in the operation of the OxyChem facility in Lake Charles, which was later transformed into a joint venture with Lyondell Chemical Company and Millennium Chemicals, called Equistar Chemical, LP. The Westlake Group also began local operations after purchasing, from OxyChem, the original Cities Service polymer plant in 1986. Major expansions followed for the Westlake Group, including the commissioning of the polyethylene plant in 1988 and the petrochemicals plant in 1989.

The 1990s have seen expansion or transfer of many of the larger industrial facilities already in operation. Specifically, Louisiana Pigment (1992) and BioLab (1994) began operations in the area. BioLab occupies part of the original Olin/Lyondell Chemical facility. The region's industrial base has continued to grow, and today the Calcasieu Estuary supports more than 10 major petroleum refining and chemical manufacturing operations, producing a wide range of industrial chemicals, petroleum products, and commercial feedstock. In addition, the waterways of the estuary continue to support recreational activities, commercial fishing, materials transport, and a diverse ecosystem.

1.4 Previous Investigations/Site Reference Documents

A number of environmental investigations have been performed throughout the Calcasieu Estuary since the late-1980s. Numerous reference documents have been cited in the development of this RI report. The reports are publicly available through LDEQ or EPA Region 6. A brief overview of the scope and findings is presented below.

More detailed information on these reports, including a summary of the scope of the investigation, analytical protocols and detections, as well as figures showing the sample locations for each study is provided in Appendix A.

Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO), Final Report, Prepared by McNeese State University for the Louisiana Department of Wildlife and Fisheries, June 1987.

The Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO) study was prepared for the Louisiana Department of Wildlife and Fisheries. The purpose of the study was to evaluate the effects of human activities on the local ecology. The study involved surveying in the Calcasieu Estuary, from the saltwater barrier to the mouth of the Calcasieu River (near Cameron at Monkey Island).

The study concluded that the influence from the urban environment was significant in Contraband Bayou and Bayou d'Inde, with the latter bayou showing greater alterations to water quality compared to other water systems throughout the Calcasieu Estuary.

Calcasieu Estuary Water Sampling Program, Louisiana Department of Environmental Quality, 1987-1996.

LDEQ has measured ambient water conditions in the Calcasieu Estuary on a monthly basis since 1987. LDEQ collects water samples from the saltwater barrier near Lake Charles to the southern end of Calcasieu Lake and includes Bayou d'Inde, Prien Lake, and portions of the Calcasieu River and ship channel. These samples were analyzed for volatile organic compounds (VOCs) and conventional parameters such as dissolved oxygen and salinity. LDEQ did not analyze the data for Semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), or inorganic compounds.

Toxics Study of the Lower Calcasieu River, Prepared by Research Triangle Institute for the U.S. Environmental Protection Agency-Region VI, Louisiana Department of Environmental Quality and U.S. Geological Survey, March 1990.

The Toxics Study of the Lower Calcasieu River summarizes the results of a toxics study conducted by EPA Region VI, LDEQ, and the U. S. Geological Survey (USGS). The study area included the Lower Calcasieu River, Bayou d'Inde, Bayou Verdine, Prien Lake, Lake Charles, Moss Lake, and Calcasieu Lake. Samples were collected in June and July of 1988 and April 1989. The report concluded that a variety of organic and inorganic constituents exist in the various media, which resulted in high mortality rates of benthic species within the estuary.

Bayou d'Inde Expanded Site Inspection - Final Report, Prepared by PRC Environmental Management, Inc. (PRC) for the U.S. Environmental Protection Agency-Region VI, September 1993.

The Bayou d'Inde Expanded Site Inspection was prepared for EPA as part of the CERCLA Hazard Ranking System screening process. The objectives of this study were to document contamination in Bayou d'Inde and to build on previously collected data by further defining site waste characteristics, contaminant sources, and exposure pathways. Samples were collected in November and December 1992.

Samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and inorganic elements. Numerous inorganic and organic contaminants were documented in Bayou d'Inde, specifically concentrated from the industrial areas to its confluence with the Calcasieu River. Similar contaminants were also documented in the PPG Canal.

Site Inspection for Bayou Verdine, Prepared by PRC Environmental Management, Inc. for the U.S. Environmental Protection Agency - Region VI, May 1994.

The Site Inspection for Bayou Verdine was focused on areas of elevated contaminant concentrations. The study objective was to document the presence of hazardous substances in surface water and sediments from PPG's North Dock (the northern section of Coon Island Loop) and Bayou Verdine. Samples were collected from 27

stations in July 1993. Sediments were analyzed for VOCs, SVOCs, PCBs, pesticides, and inorganic compounds.

The primary COPCs identified were benzo(a)pyrene; dibenz(a,h)anthracene; 1,2-dichloroethane; 1,1,2-trichloroethane; vinyl chloride; benzene; chromium; lead; and mercury.

Results of Preliminary Sediment and Surface Water Sampling and Analysis in Bayou Verdine and Coon Island Loop of the Calcasieu River, Prepared by McLaren/Hart Environmental Engineering - ChemRisk Division for PPG Industries, Inc., 1994.

The study characterized the nature and extent of chemical contamination in Coon Island Loop (including the PPG North Dock facilities) and a section of Bayou Verdine (from Interstate Highway 10 to the Coon Island Loop) for PPG. The study included 58 sampling stations evenly distributed within the study area. Samples were collected in October 1993. Analytical results showed elevated concentrations of organic and inorganic contaminants in the areas sampled.

Bayou d'Inde, Lower PPG Canal, Calcasieu River Ship Channel Water and Sediment Sampling Report, Prepared by McLaren/Hart Environmental Engineering - ChemRisk Division for PPG Industries, Inc., June 1995.

The sampling report was prepared for PPG with the objective to assess sediment and water quality in Bayou d'Inde, the Lower PPG Canal, and a portion of the Calcasieu Ship Channel. Water and sediment samples were tested for VOCs, SVOCs, PCBs, chlorinated pesticides, total petroleum hydrocarbons (TPHs), total and dissolved inorganic compounds, ammonia, and major anions. The report concluded that although many constituents were detected in surface water, there were no organic or inorganic contaminants that warranted additional characterization. However, for sediment, most organic and inorganic constituents were detected and warranted additional investigation to fully characterize the area.

Findings Report for the Focused Site Assessment - Bayou d'Inde, Prepared by Fluor Daniel, Inc. for U.S. Environmental Protection Agency - Region VI, August 1997.

The Bayou d'Inde Focused Site Investigation was conducted for EPA Region VI as part of the CERCLA site investigation process. The sampling was initiated in response to a proposed dredging permit within the lower 1,000 feet of Bayou d'Inde. All samples were analyzed for VOCs, SVOCs, inorganic compounds, PCBs, and pesticides. Five sediment samples were also analyzed for dioxin. The findings suggest contaminated sediment to a maximum depth of 16.5 feet; however, the majority of the contaminants occurred in the upper 4 feet. Elevated concentrations of three dioxins were reported. The report estimated approximately 65,000 cubic yards of contaminated sediment in the area proposed for dredging.

Calcasieu River Estuary Biological Monitoring Program: Annual Report April 1997 – January 1998 (Year 9) Prepared by QST Environmental Inc. for PPG Industries, Inc., Louisiana Department of Health and Hospitals, and Louisiana Department of Environmental Quality, July 1998.

Quarterly field sampling and chemical analyses has been conducted by PPG since 1989. Aquatic organisms where collected from 11 stations from the Calcasieu River above Lake Charles to the Gulf of Mexico. The study targeted seven species of fin and four species of shellfish. Fish and shellfish samples were analyzed for chlorinated hydrocarbon compounds and PCBs.

The principal findings of the study indicated that Bayou d'Inde and the PPG Canal contained the most contaminated fish and shellfish in the Calcasieu Estuary. The contaminants with the highest concentrations included hexachlorobenzene, hexachlorobutadiene, PCB Aroclor 1254, and pentachlorobenzene. Blue catfish, channel catfish, brown shrimp, black drum, blue crab, and spotted sea trout were the most contaminated species within the estuary.

Bayou Verdine Investigation, Nature and Extent Investigation, Lake Charles, Louisiana, prepared by Entrix, Inc., for Conoco, Inc., October 1999.

The Bayou Verdine Investigation, Nature and Extent Investigation was completed on the behalf of Conoco to characterize the nature of chemical constituents in Bayou. Sampling included VOCs, pesticides, inorganic compounds, Polynuclear aromatic hydrocarbon (PAHs), SVOCs, dioxins/furans, and PCBs. Ninety-six sediment samples and associated water samples were collected. The data indicated the highest concentrations of many of the chemical constituents were found in the lower reaches of Bayou Verdine.

1.5 Report Organization

This RI report consists of the following sections:

Section 1 - Introduction

Section 2 - Environmental Setting

Section 3 – Conceptual Site Model

Section 4 - Data Collection, Analysis, and Interpretation

Section 5 - Chemical Fate and Transport

Section 6 – Reference Area Comparison

Section 7 - Bayou d'Inde Nature and Extent of Contamination

Section 8 - Bayou Verdine Nature and Extent of Contamination

Section 9 - Upper Calcasieu Estuary Nature and Extent of Contamination

Section 10 - Lower Calcasieu Estuary Nature and Extent of Contamination

Section 11 – Biota Nature and Extent

Section 12 – Toxicity Testing and Benthic Community Survey

Section 13 - Baseline Ecological Risk Assessment (BERA) Summary

Section 14 – Human Health Risk Assessment (HHRA) Summary

Section 15 – Nature and Extent - Summary and Conclusions

References

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Appendices